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Don't Look at My Answer: Subjective Uncertainty Underlies Preschoolers' Exclusion of Their Least Accurate Memories



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Abstract

Preschoolers' ability to introspect and make decisions on the basis of these introspections has traditionally been questioned. The present research introduces a novel paradigm to examine the development of the connection between subjective uncertainty about memory and decision making in preschoolers. Three-, 4-, and 5-year-olds ($N = 81$) encoded items presented once or twice. They then completed a forced-choice test, provided confidence judgments for each response, and decided whether to select or exclude answers to be evaluated for the possibility of reward. Four- and 5-year-olds, but not 3-year-olds, reported lower certainty for incorrect and weaker memories than for correct and stronger memories, and they judiciously excluded their least confident memories, which resulted in accuracy gains for selected memories; these findings highlight age-related improvements in introspection on memory accuracy. Among accurate responses only, even 3-year-olds excluded their least confident answers, which suggests that the connection between uncertainty and decision making precedes the ability to monitor memory accuracy.

Keywords

preschoolers, confidence, uncertainty, memory, monitoring, control, open data

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Successful self-guided learning and decision making require that people accurately monitor their mental states and processes (i.e., conduct metacognitive monitoring) and then translate the output of their monitoring into adaptive behavioral responses (i.e., exert metacognitive control; Flavell, 1979; Krebs & Roebbers, 2010; Nelson & Narens, 1990). For example, when taking a test, people may take an adaptive approach by monitoring how confident they feel about their answers and then retaining the answers they feel confident about (Hembacher & Ghetti, 2013). These skills have been examined extensively during the elementary school years for their clear relevance for learning in formal education settings (Schneider & Lockl, 2008), but investigations into their emergence and early development have been extremely limited.

Yet a better understanding of these phenomena has applied relevance not only for early education, but also for several additional domains. For example, knowledge about young children's ability to introspect on the quality

of their memories is essential to evaluating their credibility as eyewitnesses in legal cases (e.g., Schaaf, Alexander, & Goodman, 2008). Moreover, a better understanding of how introspection on uncertainty might guide young children's decisions would contribute to a comprehensive theory of metacognition. Critically, this investigation could help reconcile a literature that has traditionally presumed a lack of metacognitive skill until middle childhood with people's everyday observations that young children demonstrate behaviors (such as shrugging or asking for help when they cannot perform a task alone) that suggest emerging awareness of their mental states (see Ghetti, Hembacher, & Coughlin, 2013).

A small collection of studies has begun to illuminate early metacognitive skills. For example, Lyons and Ghetti

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(2013) had 3- to 5-year-olds complete perceptual discriminations and report confidence judgments on each trial. In a separate session, children completed the same test but were given the opportunity to skip questions rather than answer them. They found that children reported lower confidence for incorrect than for correct responses and were more likely to skip these low-confidence items when given the opportunity. In another study, 3- to 5-year-olds selectively sought help in an analogous perceptual-discrimination task when they reported being less certain (Coughlin, Hembacher, Lyons, & Ghetti, 2014). Thus, even 3-year-old children have demonstrated the ability to introspect on their confidence and use these introspections to guide their decisions.

This evidence suggests that the foundations of a metacognitive architecture may be in place earlier in childhood than previously thought (e.g., Flavell, Green, & Flavell, 1995). However, it is possible that there are distinct developmental trajectories for metacognition depending on the object of introspection and the nature of the decision act. For example, memory representations may be more difficult to reflect on than percepts (Harris, 1995), which are readily available for children's inspection while formulating metacognitive judgments and may be more vivid. Further, accuracy regulation may be observed later than 3 years of age if children must decide which of their answers to report in order to earn a reward rather than asking for help (Coughlin et al., 2014) or withholding responding (Lyons & Ghetti, 2013). The act of producing a response in itself may be taken as evidence of the "goodness" of the response (McDermott, 1996), which makes it particularly difficult for children to discount it. However, being able to decide which memories are reliable enough to report is critical for accuracy regulation.

To date, preschoolers' subjective experience of memory uncertainty has not been tested, and the few studies examining preschoolers' metamemory do not provide firm conclusions. For example, in a clever adaptation from comparative research, Balcomb and Gerken (2008) found that 3.5-year-olds were more likely to skip memory trials that they later answered incorrectly (compared with those they later answered correctly) when forced to answer all questions. Although these results suggest that young children might be able to regulate their performance, confidence data were not collected; thus, it was impossible to establish whether their feelings of uncertainty guided their decisions. In another study, 4- and 5-year-olds accurately predicted which piece of currently unretrievable information they would recognize if provided with options (Cultice, Somerville, & Wellman, 1983). However, this study tested children's knowledge, not memory for new information, and 3-year-olds were not tested. Overall, young children's abilities to reflect on and regulate their memory performance are largely unknown.

The Present Study

We devised a novel paradigm to pursue two goals. First, we wanted to examine whether preschool-age children were able to introspect on memory accuracy. To this end, the present memory task was similar in structure to perceptual-discrimination tasks in which even 3-year-olds demonstrated monitoring abilities (i.e., two-alternative forced-choice trials, each followed by a confidence judgment; Coughlin et al., 2014; Lyons & Ghetti, 2013). We included a memory-strength manipulation, such that items were studied once or twice, in order to examine children's awareness of stronger versus weaker accurate memories in addition to memory accuracy itself.

Second, we were interested in whether children could use their introspections on their memories to effectively regulate their behavior. No published study has demonstrated this ability in young preschoolers. We examined a novel control behavior: the decision to disclose or not to disclose individual answers after an answer has been produced. Specifically, during the retrieval phase, after providing a confidence judgment about their memory response, participants were asked to sort their responses into two boxes, one of which they thought we would evaluate for determination of their final reward and the other of which we would ignore. We chose this selection behavior because of its relevance for eyewitness testimony (Roebbers, Moga, & Schneider, 2001) and formal education settings (Krebs & Roebbers, 2010).

If the fundamental architecture of metacognition reflected in previous perceptual-discrimination tasks equally underlies performance in the present memory task, 3- to 5-year-olds should demonstrate evidence of both monitoring and control, though improvements in these skills during the preschool years should also be observed (Lyons & Ghetti, 2013). Alternatively, the ability to monitor and control memory may emerge later, consistent with the notion that metacognitive skills may vary depending on the cognitive activity being monitored (Estes, 1998; Harris, 1995) and the control behavior being examined (Ghetti et al., 2013).

Method

Participants

Eighty-one children participated in this study: twenty-seven 3-year-olds (14 males and 13 females; mean age = 42.83 months, $SD = 2.88$), twenty-eight 4-year-olds (15 males and 13 females; mean age = 53.47 months, $SD = 3.21$), and twenty-six 5-year-olds (13 males and 13 females; mean age = 65.11 months, $SD = 3.09$). Twelve additional children (ten 3-year-olds, one 4-year-old, and one 5-year-old) were tested but excluded from analyses because of chance memory performance. The sample

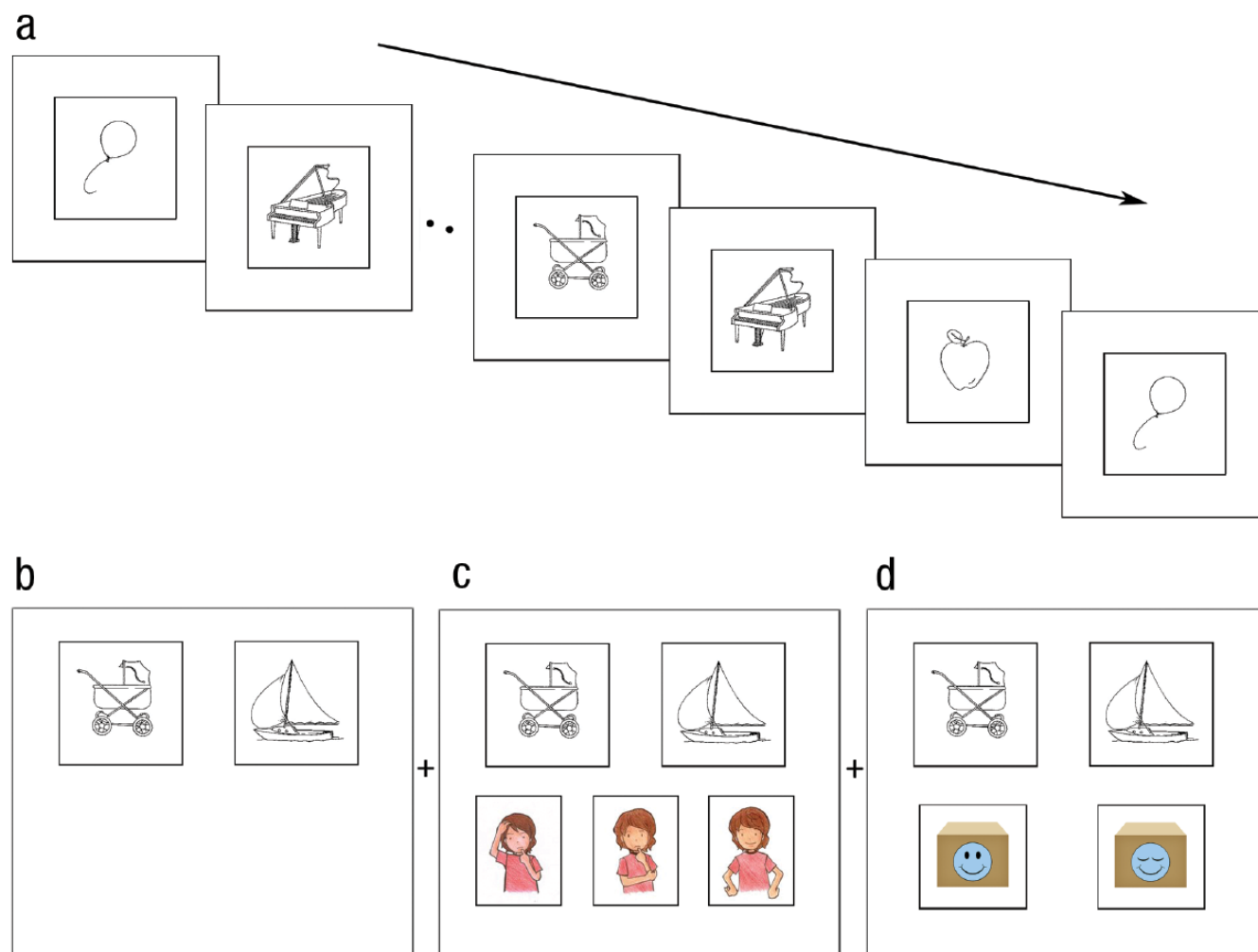


Fig. 1. Structure of the encoding and retrieval tasks. During the encoding task (a), children viewed a sequence of stimuli, half of which were presented once and half twice. During retrieval, children decided which of two drawings they had seen before (b), indicated how confident they were in their answer using a 3-point scale (c), and sorted the answers between two boxes (d) to indicate whether they wanted the experimenter to look at their answer (open-eyes box) or whether they did not want the experimenter to look at their answer (closed-eyes box).

size was selected to be comparable with previous investigations of metacognition in this age group (e.g., Lyons & Ghetti, 2011). Seventy-eight percent of children were European American, 6% were Asian American, 5% were Hispanic, 3% were African American, and 8% reported another ethnic background or did not report their ethnic background. Participants were recruited from the community.

Materials and procedure

Children visited the laboratory twice, 1 week apart. The procedures on the two visits were identical, except that different stimuli were used, such that children completed a total of 40 test trials, which resulted in sufficient data while reducing fatigue. Each visit lasted approximately 30 min and included encoding and retrieval tasks.

Encoding task. At the beginning of each visit, children completed the encoding task, in which 30 black-and-white line drawings were presented sequentially (Cycowicz, Friedman, Rothstein, & Snodgrass, 1997) on a touch-screen monitor (Fig. 1a). Stimuli were paired according to perceptual similarity (e.g., paint brush with broom) and, in most cases, pairs belonged to similar semantic categories (e.g., vehicles, kitchen utensils, fruits and vegetables) because of the perceptual-similarity constraint. Half of the images were presented once for 2,000 ms each (single-presentation items), and the remaining half were presented twice for 2,000 ms each (repeated items). To-be-repeated items were presented in random order in an initial block, followed by a second block consisting of both new and repeated items also presented in random order. Ten of these items were later used during the training phase of the retrieval task, and

the other 20 were used during the testing phase. To ensure that children attended to the images, we instructed them to touch each picture as soon as it appeared on the screen.

Retrieval-training task. Encoding was followed by retrieval training. Children first completed two practice trials to orient them to the task demands: They were shown a pair of images on the monitor—one studied and one new image—and told to select the image they saw previously by touching it on the screen (Fig. 1b). For these two trials, they received feedback about their accuracy. Novel items in the practice and real tests were also selected from Cywicz et al. (1997), and their use as distractors or targets was counterbalanced. Both the training and test phases included equal numbers of single and repeated items.

Next, children were introduced to the 3-point confidence scale (Fig. 1c). Each point on the scale was represented by an illustration of a child displaying a facial and body expression indicating, respectively, low, moderate, or high confidence. The experimenter explained that children should press the low-confidence face when they were “not so sure,” the middle-confidence face when they were “kind of sure,” and the high-confidence face when they were “really sure.” The experimenter verified that children understood the meaning of the faces by asking them which one they would press when they were “not so sure,” “kind of sure,” and “really sure.” If the child indicated the wrong face, they were corrected, and the faces were explained again until all confidence faces were correctly identified.

Next, children completed four training trials, in which they were given feedback regarding their use of the confidence faces. For each trial, they first indicated which of two drawings on the screen they had seen before. Next, they were asked to provide a confidence judgment by touching the face on the confidence scale corresponding to their confidence. Children were given feedback on their response on the basis of the correspondence between their behavioral response and their selection on the confidence scale (see Lyons & Ghetti, 2013, for further explanation of confidence-scale training).

Next, the sorting task was explained. Children were told that during the game, they could sort their answers into two boxes (Fig. 1d). One box had a smiley face with its eyes open, and the other had a smiley face with its eyes closed. Children were told that they should press the box with open eyes when they thought they had done well and wanted the experimenter to look at their answer, and they should press the box with closed eyes when they thought they might have made a mistake and did not want the experimenter to look at their answer.

Children were told that only the items in the open-eyed box would be evaluated to determine the final prize. We avoided language referring to certainty to prevent conflation with confidence judgments. We verified that children understood the meaning of the two boxes before proceeding by asking them to point to the boxes they would use if they wanted us to look at their answer and if they did not want us to look at their answer. If they did not respond correctly, the boxes were explained again until children demonstrated understanding. Children then completed four additional practice trials, in which they provided recognition and confidence judgments, and made sorting decisions about each answer.

The actual test included 20 trials, during which children received no feedback. Children saw a pair of images on the screen, including one studied and one new item, and were asked to identify the previously seen one. Then they were prompted for a confidence judgment. Finally, the boxes with the smiley faces appeared on the screen, and children pressed either the open-eyes box or the closed-eyes box. All children were given the prize of their choice regardless of their performance and were thanked for participating.

Results

Memory performance

To confirm that there were no age differences in overall memory accuracy, we conducted a 3 (age group: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (encoding type: single vs. repeated) mixed analysis of variance (ANOVA) with accuracy rate as the dependent measure. There was no main effect of age group on accuracy, $F(2, 78) = 1.09$, $p = .34$, $\eta_p^2 = .03$, nor did age group interact with encoding type, $F(2, 78) = 0.45$, $p = .64$, $\eta_p^2 = .01$. Thus, any age differences in monitoring confidence or sorting behavior cannot be attributed to task difficulty. Additionally, there was a main effect of encoding type, $F(2, 78) = 36.34$, $p < .001$, $\eta_p^2 = .32$: Accuracy (measured as the proportion of correct responses) was higher for repeated items ($M = .89$, $SD = .13$) than for items presented once ($M = .82$, $SD = .12$), which indicates that our memory-strength manipulation was successful.

Monitoring memory accuracy and strength

To examine the extent to which confidence judgments corresponded to accuracy and memory strength, we calculated mean confidence scores (low-confidence responses were coded as 0, medium-confidence responses as 1, and high-confidence responses as 2). Mean confidence scores were entered as the dependent measure into a 3 (age

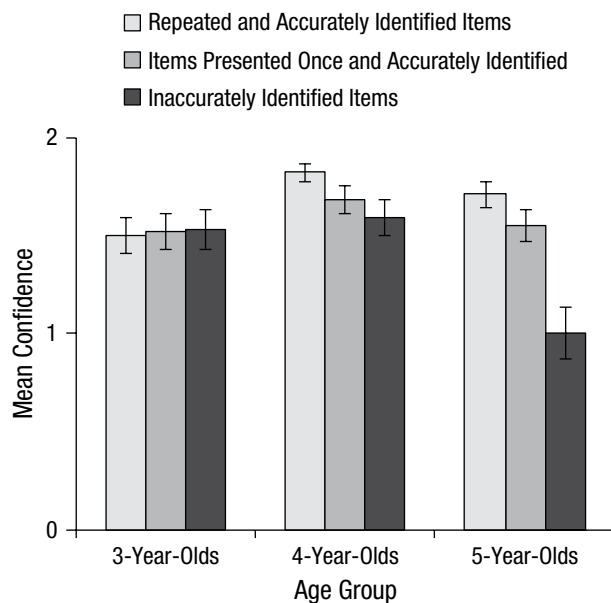


Fig. 2. Mean confidence score as a function of age group and item type. Error bars represent standard errors.

group: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 3 (item type: repeated and accurately identified items vs. items presented once and accurately identified vs. inaccurately identified items) mixed ANOVA. Four 3-year-olds were excluded from this analysis because they had no incorrect responses.

Results revealed a main effect of item type, $F(2, 148) = 19.24, p < .01, \eta_p^2 = .21$, which was qualified by a significant interaction between item type and age group, $F(4, 148) = 10.57, p < .01, \eta_p^2 = .22$ (Fig. 2). Specifically, among 3-year-olds, confidence did not differ significantly as a function of item type. In contrast, among 4-year-olds, confidence was higher for accurately identified repeated items than for accurately identified items presented once, $F(1, 27) = 7.64, p < .05, \eta_p^2 = .22$, and for inaccurately identified items, $F(1, 27) = 6.53, p < .05, \eta_p^2 = .20$. Finally, among 5-year-olds, confidence was higher for accurately identified repeated items than for accurately identified items presented once, $F(1, 25) = 18.14, p < .001, \eta_p^2 = .42$, and higher for accurately identified items presented once than for inaccurately identified items, $F(1, 25) = 17.35, p < .001, \eta_p^2 = .41$.

Although 3-year-olds did not demonstrate monitoring at the item level, we asked whether they might be aware of how well they were performing overall during the task. To address this possibility, we performed a median split by overall accuracy including all 3-year-olds (high performers: $M = .95, SD = .04$; low performers: $M = .72, SD = .11$) and compared overall confidence for low- and high-performing children. We found that low-performing 3-year-olds had lower confidence scores overall ($M = 1.37, SD = 0.42$) than high-performing 3-year-olds ($M = 1.69,$

Table 1. Mean Proportion of Responses at Each Level of Confidence

Age group and item type	Confidence		
	Low	Medium	High
3-year-olds ($n = 27$)			
Accurately identified	.18 (.20)	.11 (.18)	.72 (.26)
Inaccurately identified ^a	.16 (.22)	.15 (.22)	.69 (.31)
Overall	.17 (.20)	.11 (.18)	.71 (.27)
4-year-olds ($n = 28$)			
Accurately identified	.07 (.09)	.10 (.14)	.83 (.20)
Inaccurately identified	.17 (.23)	.07 (.10)	.76 (.29)
Overall	.08 (.10)	.10 (.12)	.82 (.20)
5-year-olds ($n = 26$)			
Accurately identified	.12 (.14)	.13 (.14)	.76 (.23)
Inaccurately identified	.40 (.35)	.21 (.27)	.40 (.38)
Overall	.15 (.14)	.13 (.13)	.72 (.22)

Note: Standard deviations are given in parentheses.

^aIncorrect responses were produced by only 23 of the 27 three-year-olds.

$SD = 0.39$), $F(1, 26) = 4.17, p = .05$. Thus, although their confidence scores were not calibrated to their accuracy at the item level, 3-year-olds exhibited some global awareness of their overall memory performance.

To confirm that all age groups used the confidence scale similarly, we examined the distribution of trials across confidence levels for accurate and inaccurate responses and overall; patterns were similar across single and repeated items, which were therefore collapsed (Table 1). We found no age differences in overall proportions of trials given low, $p = .18$, medium, $p = .39$, and high confidence scores, $p = .40$, overall. As in our previous analysis, age differences were restricted to trials with inaccurate responses in which 5-year-olds gave significantly fewer high-confidence judgments compared with 3- and 4-year-olds, $ps < .01$.

Sorting answers

As a first step in analyzing children's sorting of answers, we looked for possible age differences in the overall rate at which children selected the closed-eyes box. We found that there were no significant age differences in the proportion of trials in which children sorted their answer into the closed-eyes box (3-year-olds: $M = .24, SD = .27$; 4-year-olds: $M = .16, SD = .25$; 5-year-olds: $M = .19, SD = .20$), $F(2, 80) = 0.70, p = .50$. No significant differences in closed-eyes box selection were found between high- and low-performing 3-year-olds (respectively, $M = .25, SD = .30$ and $M = .22, SD = .28; p = .82$), which indicates that their overall difference in confidence did not tangibly affect decisions.

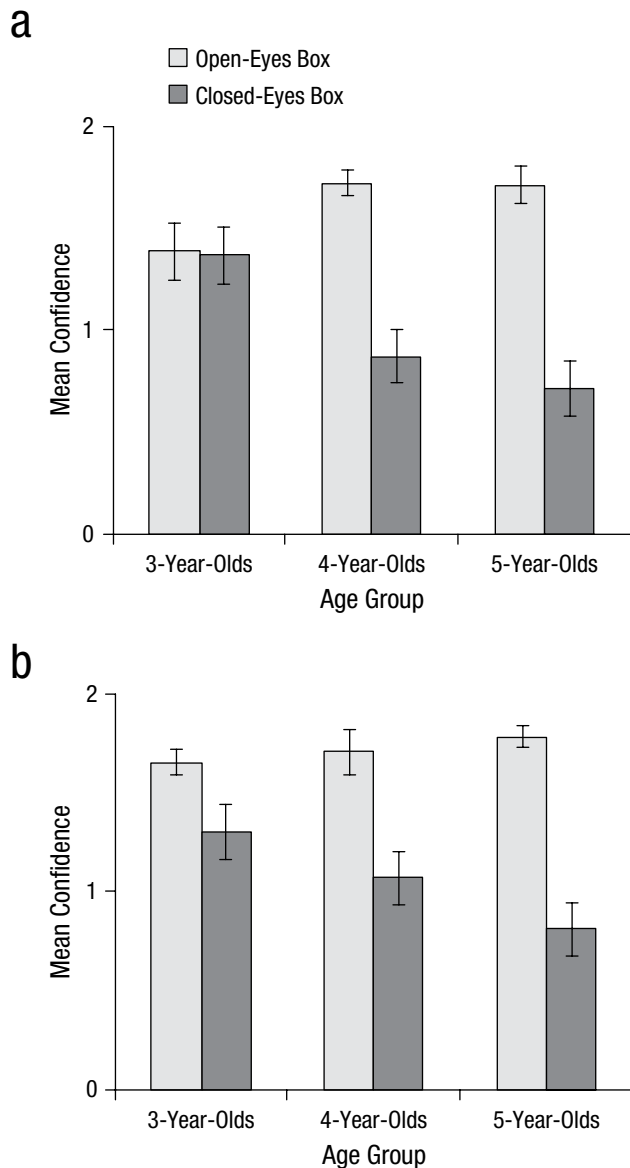


Fig. 3. Mean confidence score as a function of age group and sorting decision (a) across all trials and (b) among trials with accurate responses only. Error bars represent standard errors.

To determine how children's confidence in their answers related to their sorting decision, we next entered confidence scores as dependent measures into a 3 (age group: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (sorting: open-eyes box vs. closed-eyes box) repeated measures ANOVA. Seven 3-year-olds, nine 4-year-olds, and five 5-year-olds were excluded from this analysis and the following one because they sorted their answer into the open-eyes box on every trial. There was a main effect of sorting, $F(1, 57) = 34.45, p < .001, \eta_p^2 = .38$, which was qualified by an interaction with age group, $F(2, 57) = 8.39, p < .01, \eta_p^2 = .28$ (Fig. 3a). Specifically, among

3-year-olds, there was no difference in confidence between items sorted into the open-eyes box and the closed-eyes box, $F(1, 19) = 0.01, p = .93, \eta_p^2 = .00$. Among 4-year-olds and 5-year-olds, confidence was higher for the open-eyes box compared with the closed-eyes box—4-year-olds: $F(1, 18) = 23.74, p < .001, \eta_p^2 = .57$; 5-year-olds: $F(1, 20) = 35.35, p < .001, \eta_p^2 = .64$. In summary, 4- and 5-year-olds, but not 3-year-olds, sorted the items they were most confident about into the open-eyes box.

Next, to verify that children's sorting on the basis of confidence was associated with successful placement of their inaccurately identified items into the closed-eyes box, we entered accuracy scores as dependent measures into a 3 (age group: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (sorting: open-eyes box vs. closed-eyes box) mixed ANOVA. There was a main effect of sorting, $F(1, 57) = 32.41, p < .001, \eta_p^2 = .36$, such that items sorted into the open-eyes box were more likely to be accurate than items sorted into the closed-eyes box. This main effect was qualified by an interaction with age group, $F(2, 57) = 3.84, p = .03, \eta_p^2 = .12$. Planned comparisons revealed that among 3-year-olds, accuracy rates were not significantly different between items sorted into the open-eyes box ($M = .85, SD = .15$) and the closed-eyes box ($M = .73, SD = .31$), $F(1, 19) = 2.92, p = .10, \eta_p^2 = .13$. In contrast, 4-year-olds' accuracy rates were higher for items sorted into the open-eyes box ($M = .83, SD = .15$) than into the closed-eyes box ($M = .64, SD = .25$), $F(1, 18) = 8.82, p < .01, \eta_p^2 = .33$, and 5-year-olds showed the same pattern (open-eyes box: $M = .93, SD = .05$; closed-eyes box: $M = .54, SD = .33$), $F(1, 20) = 26.22, p < .001, \eta_p^2 = .57$. Thus, 4- and 5-year-olds, but not 3-year-olds, selectively sorted accurately identified items into the open-eyes box.

Though the results presented so far strongly suggest that confidence underlies sorting decisions resulting in accuracy gains, one may argue that other factors supporting accuracy might also underlie confidence and sorting decisions. To address this possibility, we conducted a final analysis restricted to accurately identified items and asked whether confidence guided sorting behaviors independently of objective accuracy. This analysis has the additional advantage of eliminating trials on which children may not have been fully attending. Three 3-year-olds, seven 4-year-olds, and seven 5-year-olds were excluded from this analysis because they did not choose the closed-eyes box for any accurately identified items. A 3 (age group: 3-year-olds vs. 4-year-olds vs. 5-year-olds) \times 2 (sorting: open-eyes box vs. closed-eyes box) ANOVA with mean confidence as the dependent measure yielded a main effect of sorting, $F(1, 60) = 44.36, p < .001, \eta_p^2 = .43$, such that items sorted into the closed-eyes box were overall associated with lower confidence scores ($M = 1.08, SD = 0.65$) than items sorted into the open-eyes box ($M = 1.71, SD = 0.37$; Fig. 3b).

This main effect was qualified by an interaction between sorting and age group, $F(2, 60) = 3.43$, $p < .05$, $\eta_p^2 = .10$, such that the correspondence between sorting and confidence increased with age. Despite this improvement with age, all age groups had higher confidence scores for items placed in the open-eyes than in the closed-eyes box—3-year-olds: $M = 1.66$, $SD = 0.33$, vs. $M = 1.30$, $SD = 0.68$, $p < .05$; 4-year-olds: $M = 1.70$, $SD = 0.51$, vs. $M = 1.07$, $SD = 0.59$, $p < .01$; 5-year-olds: $M = 1.78$, $SD = 0.24$, vs. $M = 0.81$, $SD = 0.58$, $p < .01$. Thus, when inaccurately identified items were removed, even 3-year-olds sorted their responses on the basis of confidence.

Discussion

The goal of the present research was to examine young children's abilities to introspect on their memory uncertainty and to make decisions on the basis of these assessments. Previous studies found that children as young as 3 years were less confident in their incorrect than in their correct perceptual identifications, which provides evidence of successful uncertainty monitoring, and elected to withhold responses (Lyons & Ghatti, 2013) or ask for help (Coughlin et al., 2014) when they felt uncertain.

In contrast, in the present study, 4- and 5-year-olds, but not 3-year-olds, were more confident when they provided the correct than the incorrect memory response, which supports the idea that monitoring ability may depend on the mental process being monitored. Nevertheless, this is the first evidence that children as young as 4 years of age can explicitly report on their uncertainty in their memory responses. Moreover, confidence judgments showed that 4- and 5-year-olds not only differentiated between accurate and inaccurate responses, but also between items studied twice versus once, which indicates their ability to differentiate stronger compared with weaker memories in addition to their ability to discriminate between memory presence and absence. It is important to note that repeated encoding, in addition to increasing memory strength, may have also increased the vividness or fluency of stimuli, both of which are known to be cues to memory monitoring for adults (Koriat, 2007). Future research should attempt to distinguish the types of memory cues children may learn to attend to early in development.

Despite the absence of uncertainty monitoring at the item level in 3-year-olds, when we examined the overall confidence of children with high and low memory performance, we found that low-performing children were overall less confident than high-performing children. This could reflect an emerging awareness among 3-year-olds that one is or is not performing well in a task overall, which suggests that global performance assessments may precede the ability to reflect on uncertainty in individual

memory responses. Until recently, dramatic improvements in metamemory monitoring observed during the elementary school years (Schneider & Lockl, 2008) have contributed to the perception that younger children are unlikely to monitor their memory processes. Our results provide evidence of memory monitoring much earlier and invite further investigations into the limitations of early metacognitive awareness.

With respect to metacognitive control, we found that 4- and 5-year-olds, but not 3-year-olds, sorted their answers judiciously on the basis of their subjective confidence when considering all trials. However, when we restricted the analysis to trials with accurate responses, we found that all age groups relegated the items they were less confident about to the closed-eyes box. One possible explanation for this observation is that children were not as fully engaged in trials on which they responded inaccurately compared with trials on which they responded accurately; thus, they may not have sorted their answers as carefully on these trials. Although we cannot directly test this possibility, it is important to note that confidence and sorting were well-calibrated among trials with accurate responses, which suggests that these introspections led to choice independent of objective memory performance. Since 4- and 5-year-olds' confidence judgments were calibrated with their accuracy, they maximized their performance through their sorting behaviors; this was not the case for 3-year-olds. Nevertheless, 3-year-olds' placement of more confident answers in the open-eyes box compared with the closed-eyes box suggests that 3-year-olds may decide how to respond on the basis of subjective uncertainty before they can reliably assess the quality of their memories.

Previous findings have shown that preschoolers can strategically adapt their responding on the basis of metacognitive monitoring (Coughlin et al., 2014; Lyons & Ghatti, 2013), and the present results extend these findings to a memory context. These results are particularly notable because sorting answers to be evaluated or ignored is a less frequent control behavior than withholding answers or asking for help, both of which are routinely exhibited outside of the laboratory (Benenson & Koulouzian, 2008; Chouinard, 2007). In contrast, the experience of selecting answers to report is more likely encountered in a formal education setting later in development (Roebers, Schmid, & Roderer, 2009). Our results raise the intriguing question of whether children's learning during the preschool years could benefit from interventions that emphasize uncertainty monitoring and related decision processes.

Furthermore, our results contribute to a vast literature on the reliability of children's eyewitness testimony (Pozzulo & Lindsay, 1998) and, specifically, their subjective confidence (Brewer & Day, 2005; Howie & Roebers, 2007). Although the present results point to the emergence of

uncertainty monitoring during the preschool years, we note that the magnitude of this effect is robust in 5-year-olds but relatively small in 4-year-olds and absent in 3-year-olds. Yet preschoolers' confidence appeared to inform decisions to share or not to share the outcomes of their memory searches, which suggests that older, but not younger, preschoolers may appear appropriately more confident when they choose to report veridical rather than false memories.

Author Contributions

E. Hembacher and S. Ghetti designed the study. Data were collected, analyzed, and interpreted by E. Hembacher under the supervision of S. Ghetti. E. Hembacher drafted the manuscript, and S. Ghetti provided critical revisions. Both authors approved the final version of the manuscript for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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Open Practices



All data have been made publicly available via Open Science Framework and can be accessed at <https://osf.io/5zimh/>. The complete Open Practices Disclosure for this article can be found at <http://pss.sagepub.com/content/by/supplemental-data>. This article has received the badge for Open Data. More information about the Open Practices badges can be found at <https://osf.io/tyvxyz/wiki/view/> and <http://pss.sagepub.com/content/25/1/3.full>.

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